THE TWO-STAGE MODEL OF PROTOPLANETARY MATTER IRRADIATION. A. K. Lavrukhina, V. I. Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Science, Moscow, Russia.

The systematization of the data on the content of planetary type (A type) and solar type (B type) noble gases, and precompaction records of the irradiation of constituent grains and chondrules by solar wind (SW) and solar flare particles (SFP) in gas-rich meteorites and C and O chondrites [1,2] allows us to propose a new two-stage model of protoplanetary matter irradiation.

The first stage took place in the gas-dust protoplanetary nebula on the T Tauri stage ($t \sim 10^7$ yr). After the Sun stopped accreting, the coronal expansion SW began. The plasma of the SW carried magnetic field lines, which probably became embedded in the surface layers of the protoplanetary disk [3]. Following a magnetic sector reversal, magnetic reconnection at the disk interface could take place leading to rapid motion of disk matter. At the expense of magnetic energy isolation during magnetic field reconnection, giant flares and shock waves occurred. In this region there is also a neutral drift line and chondrule formation and chondrite accumulation can be expected to have taken place there. The shock waves accelerated charged particles and ions that could have formed by means of γ radiation of ^{26}Al, ^{40}K, ^{53}Mn, and ^{107}Pd. Solar wind and magnetic field lines carried off gas from the inner region of the disk, leading to gas dissipation, disk packing, and more intensive processing of its matter by flares and shock waves. The relics of these processes are discovered in chondrule crystals and the matrix of C and O chondrites as fossil tracks of low-energy VH nuclei (E < 100 MeV/nucleon). Most C chondrites have no solar-type gases. The contents of planetary ^{20}Ne-A lie within the limits of 6×10^{-8} cm^3 g^{-1} (Allende CV) to 63×10^{-8} cm^3 g^{-1} (Murray CM) [4]. The VH-track densities are ρ + 10^5–10^8 cm^{-2} [5]. The ρ distributions of various samples are very heterogeneous. Some of the samples have no VH tracks. Very few grains show 2π irradiation geometry. The measured VH-track density profiles in irradiated grains correspond to the observed track records in the Surveyor camera glass exposed on the lunar surface. The spectrum index of VH-nuclei is $\gamma = 3$. However, the VH-track density profile in olivine crystal of Allende chondrule indicates a value of $\gamma = 5$–6 [6]. The O chondrites contain only small amounts of planetary noble gases. For example, the amounts of ^{20}Ne-A are 2.10^{-8} cm^3 g^{-1} [4]. The VH-track densities are also very low: $\rho = 10^6$–10^7 cm^{-2} [7]. The O chondrites have a very small portion of irradiated crystals (1%). The VH-track density profile distributions in chondrule crystals are nonisotopic. The angular distributions of VH tracks in the grains of C and O chondrites indicate that most of them were irradiated in a simple one-stage irradiation geometry.

The second stage of irradiation of meteoritic matter took place after the full dissipation of gas from the inner region of the solar system. Solar wind and SFP irradiated the parent asteroid surfaces. Maximum irradiation could have taken place during catastrophic fragmentation and reassembly of parent asteroids [8]. Some of the kilometer-sized objects may have suffered catastrophic break-up dispersing small fragments into space. The small fragments then received SFP and SW irradiation in space before reaccumulation into large meteorite parent bodies. The relics of these processes are discovered in gas-rich meteorites: howardites, aubrites, chondrites, and others [1,2]. These meteorites have the light-dark structure of breccia and contain foreign xenoliths. The darker hosts contain the light noble gases of solar type (B type) in large amounts and SFP-irradiated grains. The contents of ^{20}Ne-B lie within the limits of $\sim 2 \times 10^{-5}$ cm^3 g^{-1} (aubrite Staroe Pesyanoe) to $\sim 3.10^{-4}$ cm^3 g^{-1} (chondrite Fayetteville H3-4) [4]. The VH-track densities in irradiated grains are very high, up to 10^{11} cm^{-2} (Fayetteville H3-4, fraction of d < 5 μm). The amounts of irradiated grains are 30% [1]. Most grains have VH-track density profiles corresponding to $\gamma = 3$. Only some of the grains of howardite Kapoeta and chondrite Fayetteville have γ 2. The same grains are very widespread in lunar regolith. The C chondrites Nogoya CM and Mokoia CV have the light-dark structure of breccia, higher contents of the B-type noble gases, and VH-track densities (10^9 cm^{-2}). A few percent of grain aggregates and chondrules in CM-chondrites Murchison and Murray are irradiated as individual entities [1]. Apparently, some C chondrites had two-stage procompaction irradiation.

References: [1] Goswami J. N. et al. (1984) *Space Sci. Rev. 37,* 111. [2] Lavrukhina A. K. (1996) *Geochimia*, in print (in Russian). [3] Cameron A. G. W. (1995) *LPS XXVI,* 221. [4] Schultz L. and Kruse H. (1989) *Meteoritics, 24*, 155. [5] Korotkova N. N. and Lavrukhina A. K. (1979) *Geochimia*, 1267 (in Russian). [6] Korotkova N. N. et al. (1979) *Geochimia*, 420 (in Russian). [7] Kashkarov L. L. et al. (1988) *Meteoritika, 47,* 113 (in Russian). [8] Keil K. et al. (1995) *Planet. Space Sci. 42*, 1109.